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(54) **TOUCH PANEL**

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G06F 1/16 (2006.01)

G06F 3/044 (2006.01)

(52) **U.S. Cl.**

CPC **G06F 1/1692** (2013.01); **G06F 3/044** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

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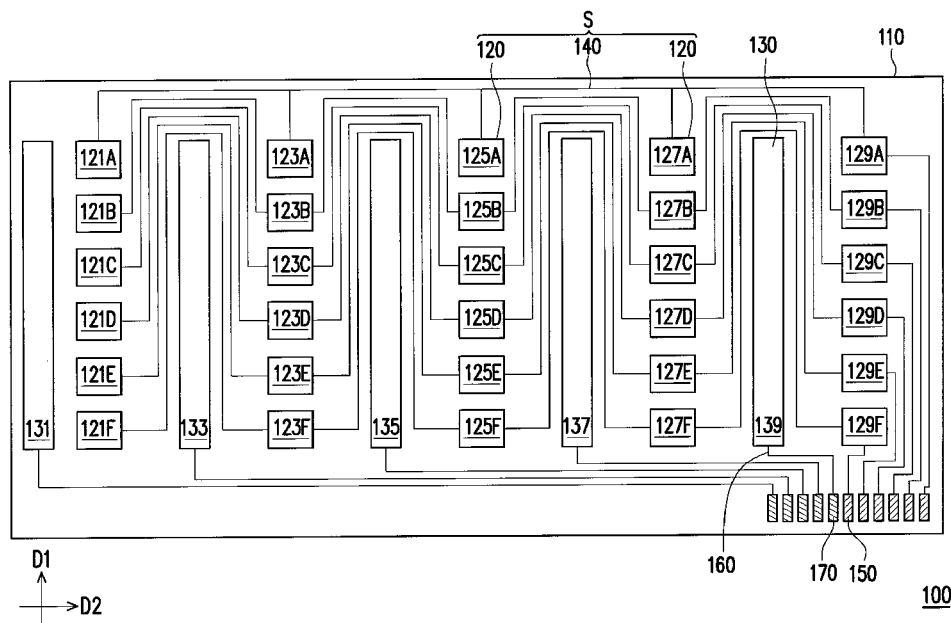
Primary Examiner — Nicholas Lee

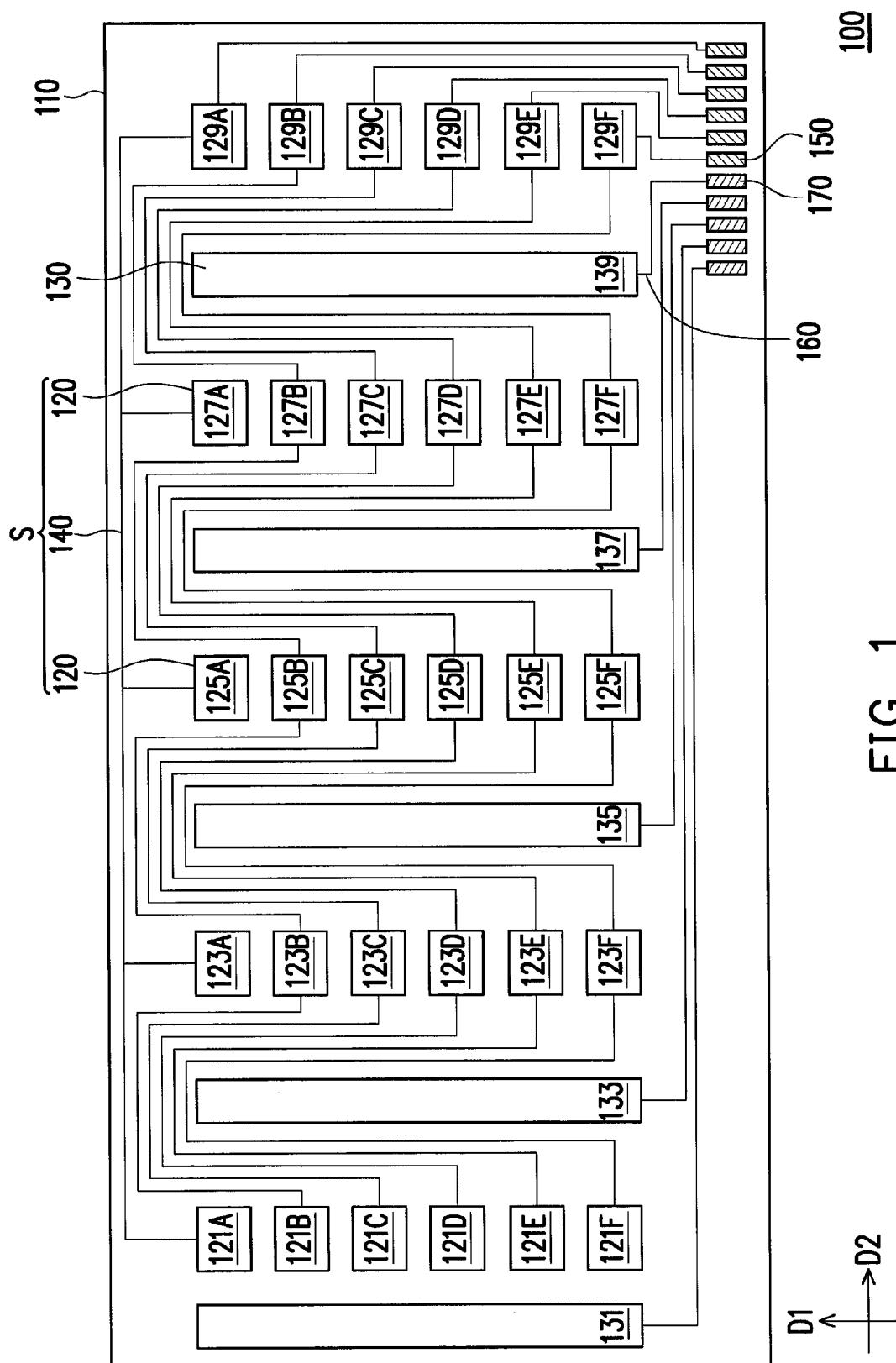
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(57) **ABSTRACT**

A touch panel, including a substrate, first electrodes, second electrodes, first connecting lines, first pads, second connecting lines, and second pads, is provided. The first electrodes are arranged in an array to define a plurality of columns each parallel to a first direction and a plurality of rows each parallel to a second direction intersecting the first direction. Each of the second electrodes is extended in the first direction. The second electrodes are sequentially arranged in the second direction so that one column of the first electrodes is disposed between two adjacent second electrodes. The first connecting lines connect the first electrodes in the same row into a series connected to one first pad. The second electrodes are connected to the second pads through the second connecting lines. The first electrodes, the second electrodes, the first connecting lines, and the second connecting lines do not intersect one another.

8 Claims, 4 Drawing Sheets





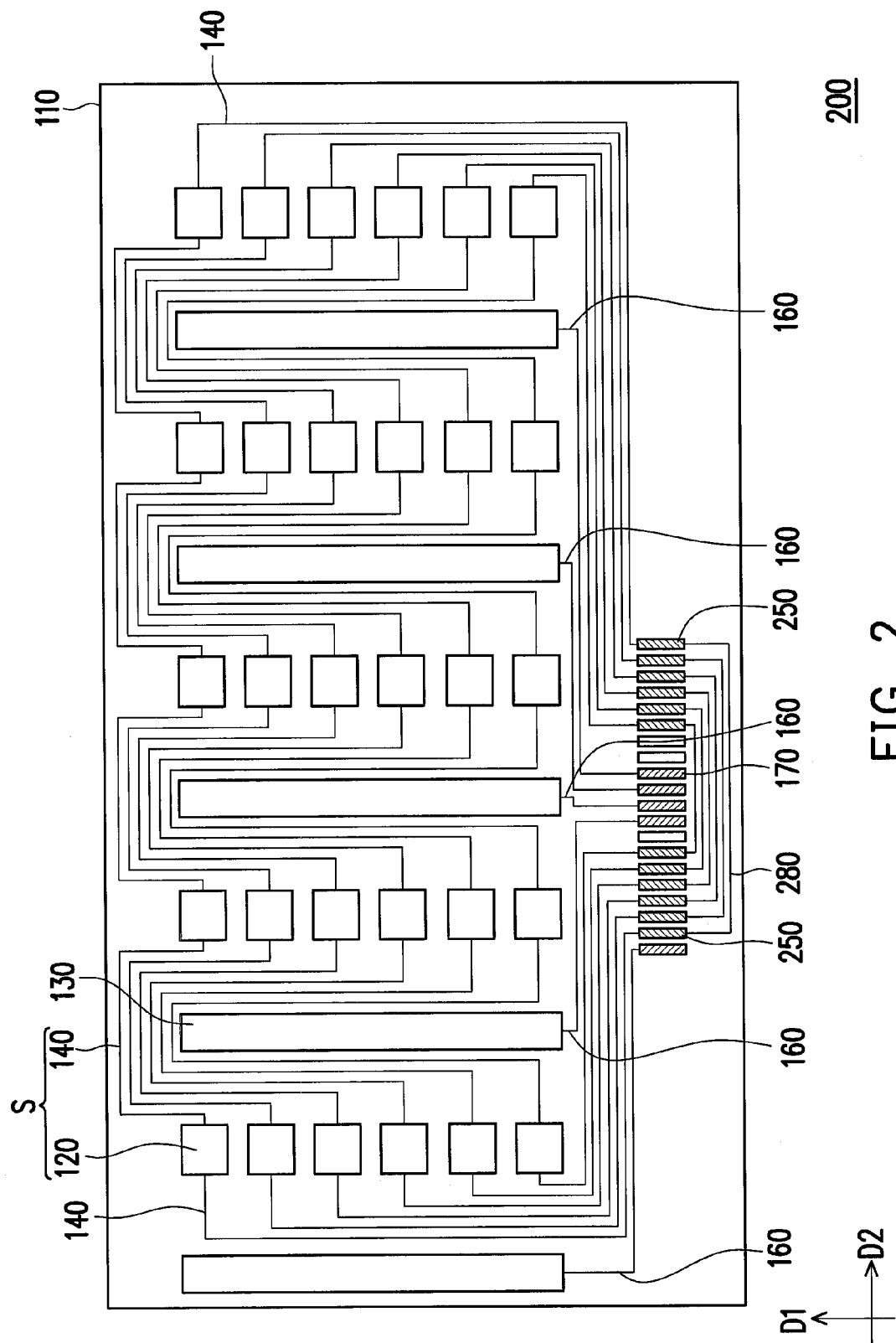


FIG. 2

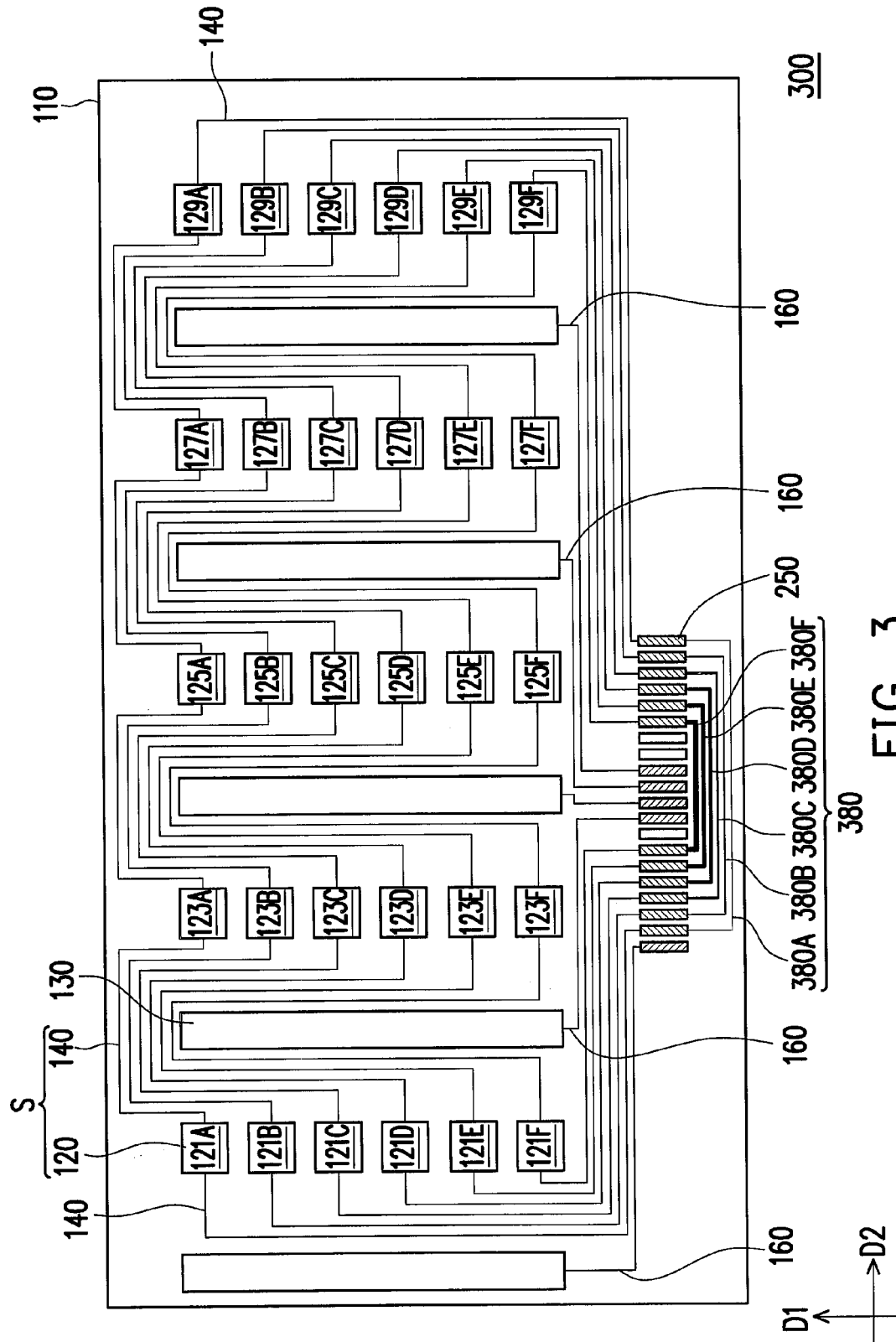


FIG. 3

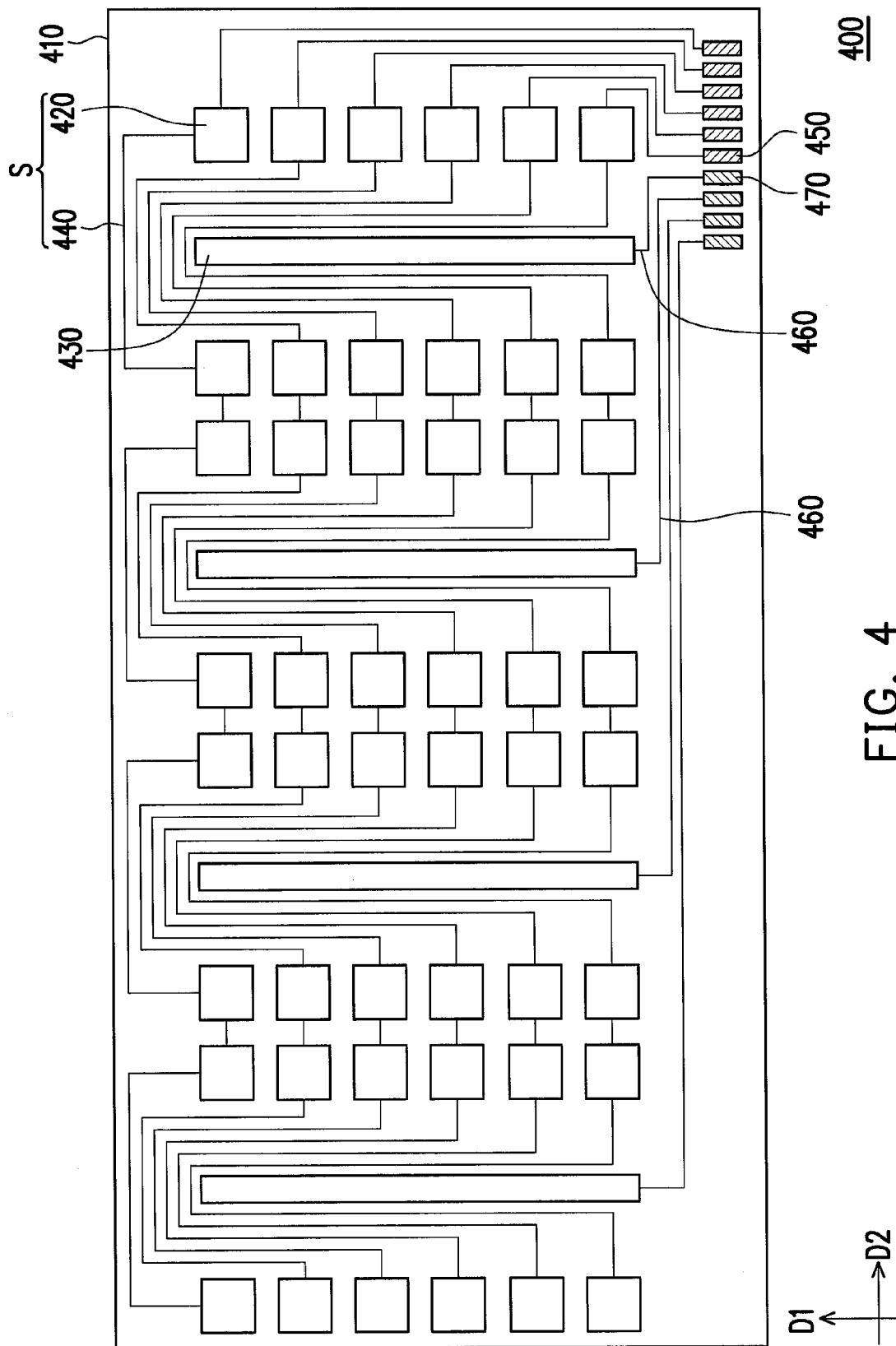


FIG. 4

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TOUCH PANEL

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan application serial no. 101141443, filed on Nov. 7, 2012. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is related to a touch panel and particularly related to a touch panel with a mutual-capacitive electrode design.

2. Description of Related Art

A projected-capacitive touch panel achieves mutual-capacitive touch sensing through sensing series that extend in different directions. In terms of structure, the sensing series that extend in different directions are disposed to intersect each other. At least two conductive layers are required for fabricating the sensing series extending in different directions, and the sensing series in different directions need to be insulated at the intersections by an insulating material. Thus, the fabrication of the projected-capacitive touch panel requires at least 3-5 material layers, and as a result, the fabrication time cannot be shortened. Especially, when the material layers are formed into the required patterns through photolithography and etching processes, since the number of masks cannot be reduced, the production costs cannot be lowered effectively.

SUMMARY OF THE INVENTION

The invention provides a touch panel, which does not require conductor elements to intersect each other, for reducing fabrication costs and shortening fabrication time.

The invention provides a touch panel, including a substrate, a plurality of first electrodes, a plurality of second electrodes, a plurality of first connecting lines, a plurality of first pads, a plurality of second connecting lines, and a plurality of second pads. The first electrodes are disposed on the substrate. The first electrodes are arranged in an array to define a plurality of columns each parallel to a first direction and a plurality of rows each parallel to a second direction intersecting the first direction. The second electrodes are disposed on the substrate. Each of the second electrodes is extended in the first direction. The second electrodes are sequentially arranged in the second direction so that one column of the first electrodes is disposed between two adjacent second electrodes. The first connecting line is connected with the first electrodes and connects the first electrodes in the same row into a series. The first pads are disposed on the substrate, and the series are connected with the first pads. The second connecting lines are connected with the second electrodes. The second pads are disposed on the substrate and connected with the second connecting lines. The first electrodes, the second electrodes, the first connecting lines, and the second connecting lines do not intersect one another.

Based on the above, a sensing device of the touch panel according to the invention is formed with conductor patterns that do not intersect each other. Therefore, an insulating material is not needed between the conductor elements, and accordingly, the fabrication time and costs of the touch panel are reduced. Moreover, in the touch panel of the embodiments

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of the invention, the connecting line connects multiple electrodes into a series. Thus, the multiple electrodes are connected to the same pad, which help reduce the number of the pads and the area required for disposing the pads.

To make the aforementioned and other features and advantages of the invention more comprehensible, several embodiments accompanied with figures are described in detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1 is a schematic diagram of a touch panel according to the first embodiment of the invention.

FIG. 2 is a schematic diagram of a touch panel according to the second embodiment of the invention.

FIG. 3 is a schematic diagram of a touch panel according to the third embodiment of the invention.

FIG. 4 is a schematic diagram of a touch panel according to the fourth embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

Referring to FIG. 1, a touch panel 100 includes a substrate 110, a plurality of first electrodes 120, a plurality of second electrodes 130, a plurality of first connecting lines 140, a plurality of first pads 150, a plurality of second connecting lines 160, and a plurality of second pads 170. The first electrodes 120, the second electrodes 130, the first connecting lines 140, the first pads 150, the second connecting lines 160, and the second pads 170 are disposed on the substrate 110 and are not intersected with each other. Moreover, the substrate 110 may be a substrate constituted by a soft material or a rigid material, such as a glass substrate, a strengthened glass substrate, a plastic substrate, a flexible cover lens, a flexible plastic substrate, for example, a plastic film, a thin glass substrate (as glass film) or a substrate of the display. Herein, the above-mentioned strengthened glass substrate may be a cover lens, and at least one side of the cover lens has a decoration layer (not shown), for example, disposed on a portion of the peripheral area or the entire region of the peripheral area. The above-mentioned substrate of the display may include a color filter substrate of a liquid crystal display or a package substrate of an organic light-emitting display. Further, the above-mentioned substrate of the display can be one of the substrate and the opposite substrate. The first electrodes 120, the second electrodes 130, the first connecting lines 140, and the second connecting lines 160 may be formed of or include an indium tin oxide (ITO), an indium zinc oxide (IZO), a metal mesh material, a nano-scale metal material or a metal material etc.

In FIG. 1, a distance between the first electrodes 120 and the second electrodes 130 is exaggerated to clearly illustrate the connection relationship between these electrodes. Please note that the sizes of the elements described/shown in the following embodiments and figures are for illustration only and are not intended to limit the invention. In fact, a distance between each first electrode 120 and the adjacent second electrode 130 may be less than a width of at least one of the first electrode 120 and the second electrode 130 in a second direction D2. Herein, the first electrodes 120 and the second electrodes 130 have millimeter-level widths in the second

direction D2; and the first connecting lines **140** and the second connecting lines **160** have micrometer-level line widths.

In this embodiment, a plurality of the first electrodes **120** may have the same pattern, but the patterns of the first electrodes **120** may be different. The first electrodes **120** are arranged in an array, for example. Herein, the first electrodes that are arranged parallel to a first direction D1 may be deemed as a column, and the first electrodes **120** arranged parallel to the second direction D2 may be deemed as a row, wherein the first direction D1 intersects the second direction D2. Therefore, the first electrodes **120** define a plurality of columns each parallel to the first direction D1 and a plurality of rows each parallel to the second direction D2, for example. According to FIG. 1, the first electrodes **120** of the touch panel **100** define five columns and six rows. However, the aforementioned values are merely examples of the invention and should not be construed as limitations to the scope of the invention. In addition, the first connecting lines **140** are used to connect the first electrodes **120** in the same row into a plurality of series S. The first pads **150** are respectively connected with the series S.

Each of the second electrodes **130** is extended in the first direction D1 and has a strip-shaped pattern. The strip-shaped second electrodes **130** are sequentially arranged in the second direction D2, so that one column of the first electrodes **120** is located between two adjacent second electrodes **130**. The second connecting lines **160** respectively connect the second electrodes **130**, and the second pads **170** are connected with the second connecting lines **160**. That is, the number of the second pads **170** is equal to the number of the second electrodes **130** and the second pads **170** and the second electrodes **130** are one-on-one connected. Accordingly, each of the first electrodes **120** is connected to a control circuit (chip) of the touch panel **100** through the first connecting line **140** and the first pad **150**; and each of the second electrodes **130** is connected to the control circuit (chip) through the second connecting line **160** and the second pad **170**.

More specifically, in the array of the first electrodes **120**, the first electrodes **121A-121F** form a first column, the first electrodes **123A-123F** form a second column, the first electrodes **125A-125F** form a third column, the first electrodes **127A-127F** form a fourth column, and the first electrodes **129A-129F** form a fifth column, for example. Moreover, the second electrodes **130** for example include the second electrode **131** corresponding to the first electrodes **121A-121F** of the first column, the second electrode **133** corresponding to the first electrodes **123A-123F** of the second column, the second electrode **135** corresponding to the first electrodes **125A-125F** of the third column, the second electrode **137** corresponding to the first electrodes **127A-127F** of the fourth column, and the second electrode **139** corresponding to the first electrodes **129A-129F** of the fifth column.

When the touch panel **100** performs touch sensing, the second electrode **130** sequentially performs scanning for the corresponding first electrodes **120** to perform sensing of a touch action. Thus, each of the second electrodes **130** may be deemed as a scanning electrode, and the first electrodes **120** located beside the each second electrode **130** may be deemed as sensing electrodes. For example, when the second electrode **131** performs scanning, the first electrodes **121A-121F** in the first column perform sensing of the touch action. Because the first electrodes **121A-121F** belong to different series S, the first electrodes **121A-121F** are not electrically connected with each other and can perform sensing at the same time. In addition, when the second electrode **133** and the second electrodes **135**, **137**, and **139** respectively perform scanning in the latter timing, the first electrodes **123A-123F**

in the second column, the first electrodes **125A-125F** in the third column, the first electrodes **127A-127F** in the fourth column, and the first electrodes **129A-129F** in the fifth column respectively perform sensing as well.

Accordingly, the first electrodes **121A**, **123A**, **125A**, **127A**, and **129A** in the same row perform the sensing respectively corresponding to different scanning timings. Therefore, in this embodiment, the first connecting line **140** connects the first electrodes **121A**, **123A**, **125A**, **127A**, and **129A** into the series S, and one first pad **150** is used to read or transmit sensing signals of the first electrodes **121A**, **123A**, **125A**, **127A**, and **129A**, and so on. Consequently, the number of the first pads **150** is significantly reduced.

Hence, in this embodiment, if the number of the columns of the first electrodes **120** is N, the number of the first pads **150** is 1/N of the number of the first electrodes **120**. In view of the above, the area required for disposing all the first pads **150** is greatly reduced, which helps to simplify the design of a pad region (a region where the first pads **150** and the second pads **170** are disposed).

Referring to FIG. 2, a touch panel **200** is similar to the touch panel **100** of the first embodiment (as shown in FIG. 1), and a difference lies in that: the touch panel **200** further includes a plurality of third connecting lines **280** and the number of a plurality of first pads **250** is the double of the number of the series S, wherein two ends of the series S are each connected to one first pad **250**. In this embodiment, the two first pads **250** that are connected to the same series S are connected by one of the third connecting lines **280**.

The first electrodes **120** that form five columns and six rows are connected into six series S, wherein each of the series S is connected to two of the first pads **250**. Hence, if the number of the columns of the first electrodes **120** is N, the number of the first pads **250** is substantially 2/N of the number of the first electrodes **120**. In addition, each of the series S is connected with one of the third connecting lines **280** in parallel, so as to reduce resistance, which helps to reduce the load of the control circuit (chip) that controls the touch panel **200**.

Referring to FIG. 3, a touch panel **300** of this embodiment is similar to the touch panel **200** (as shown in FIG. 2). Thus, elements that are the same in the two embodiments are denoted by identical reference numerals.

In this embodiment, the first electrodes **121A**, **123A**, **125A**, **127A**, and **129A** that belong to the first row are connected into one series S. The first electrodes **121B**, **123B**, **125B**, **127B**, and **129B** of the second row are connected into one series S. And the rest are connected in the same way.

It can be known from FIG. 3 that the resistances of the six series S vary according to the lengths of wiring routes of the first connecting lines **140**. Generally speaking, the resistance of an electronic signal transmission path affects the quality of signal transmission. Due to the different resistances of the six series S, the six series S may have inconsistent signal transmission quality, which impairs the touch accuracy of the touch panel **100**. Therefore, in this embodiment, the third connecting lines **380A-380F** have different patterns, so as to compensate for the resistance difference between the series S caused by the different lengths of the wiring routes of the first connecting lines **140**.

More specifically, according to the layout of FIG. 3, the first connecting line **140** that connects the first electrodes **121F**, **123F**, **125F**, **127F**, and **129F** of the sixth row into the series S has the longest wiring route. The first connecting line **140** that connects the first electrodes **121A**, **123A**, **125A**, **127A**, and **129A** of the first row into the series S has the shortest wiring route. Therefore, among the third connecting lines **380A-380F**, the third connecting line **380F** has the larg-

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est line width (relatively least resistance) and the third connecting line **380A** has the smallest line width (relatively most resistance). The line widths of the third connecting lines **380B**, **380C**, and **380D** are increased in sequence. Accordingly, through connecting the third connecting lines **380** in parallel, the equivalent resistances of the series **S** are made more uniform to achieve ideal signal transmission quality, such that the touch panel **300** provides ideal touch accuracy.

FIG. 3 illustrates that the resistances of the third connecting lines **380A-380F** are adjusted through design of the line widths; however, the invention is not limited thereto. Generally speaking, the third connecting lines **380A-380F** may be designed to have different patterns to have different resistances. Therefore, in other embodiments, the third connecting lines **380A-380F** may have different lengths of wiring routes, different film thicknesses, or different stack structures. For example, one or more of the third connecting lines **380** may have a zigzag or meandering pattern, so as to have larger resistance.

In the above embodiments, one column of the first electrodes **120** is located between two adjacent second electrodes **130**, but the invention is not limited thereto. For example, referring to FIG. 4, a touch panel **400** includes a substrate **410**, a plurality of first electrodes **420**, a plurality of second electrodes **430**, a plurality of first connecting lines **440**, a plurality of first pads **450**, a plurality of second connecting lines **460**, and a plurality of second pads **470**. The first electrodes **420**, the second electrodes **430**, the first connecting lines **440**, the first pads **450**, the second connecting lines **460**, and the second pads **470** are disposed on the substrate **410**. In addition, the first electrodes **420**, the second electrodes **430**, the first connecting lines **440**, and the second connecting lines **460** are disposed on the same plane and are not intersected with each other.

A difference between this embodiment and the above embodiments lies in that: in this embodiment, two columns of the first electrodes **420** are disposed between two adjacent second electrodes **430**. Each of the second electrodes **430** is extended in the first direction **D1** and has a strip-shaped pattern. Each of the second electrodes **430** and the two columns of the first electrodes **420** respectively located on two sides of the second electrode **430** form a sensing electrode group. When each of the second electrodes **430** performs scanning, the two columns of the first electrodes **420** respectively located on two sides of the second electrode **430** perform sensing.

In the touch panel **400** of this embodiment, the number of the first pads **450** is equal to the number of the series **S**. Nevertheless, in other embodiments, the number of the first pads **450** may be the double of the number of the series **S**, such that the two ends of the series **S** are each connected to one first pad **450**. Moreover, such a touch panel may further include the third connecting lines **280** or **380** shown in FIG. 2 or 3, so as to make the equivalent resistances of the series **S** uniform to improve the sensing quality.

To conclude the above, in the touch panel of the embodiments of the invention, multiple sensing electrodes are connected into series, such that the pads connected to the series are capable of transmitting signals of the multiple sensing electrodes. Consequently, the number of the pads is less than the number of the electrodes, which reduces the area required for disposing the pads.

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It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed embodiments without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the invention covers modifications and variations of this disclosure provided that they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. A touch panel, comprising:

a substrate;

a plurality of first electrodes disposed on the substrate and arranged in an array to define a plurality of columns parallel to a first direction and a plurality of rows parallel to a second direction intersecting the first direction;

a plurality of second electrodes disposed on the substrate and each extended in the first direction, and the second electrodes being sequentially arranged in the second direction so that one of the columns of the first electrodes is disposed between two adjacent second electrodes;

a plurality of first connecting lines connected with the first electrodes and connecting the first electrodes in the same row into a series;

a plurality of first pads disposed on the substrate, and at least one end of the series being respectively connected with the first pads;

a plurality of second connecting lines connected with the second electrodes; and

a plurality of second pads disposed on the substrate and connected with the second connecting lines, wherein the first electrodes, the second electrodes, the first connecting lines, and the second connecting lines do not intersect each other.

2. The touch panel according to claim 1, wherein two columns of the first electrodes are disposed between two adjacent second electrodes, and two first electrodes paralleled in the second direction are connected with each other by the first connecting lines.

3. The touch panel according to claim 1, wherein the number of the first pads is equal to the double of the number of the series, and two ends of the series is each connected with one of the first pads.

4. The touch panel according to claim 3, further comprising a plurality of third connecting lines each connecting two of the first pads, and the two first pads are connected with the same series.

5. The touch panel according to claim 4, wherein the third connecting lines have different patterns.

6. The touch panel according to claim 4, wherein the third connecting lines have different line widths.

7. The touch panel according to claim 1, wherein a distance between each of the second electrodes and the adjacent first electrodes is less than a width of each of the second electrodes in the second direction and less than a width of each of the first electrodes in the second direction.

8. The touch panel according to claim 1, wherein each of the first connecting lines has a micrometer-level line width, and each of the first electrodes and the second electrodes has a millimeter-level width.

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